A DISSERTATION ON

OUTCOME OF BUBBLE CPAP VENTILATION IN NICU

DISSERTATION SUBMITTED TO

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

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CHENGALPATTU MEDICAL COLLEGE, CHENGALPATTU

MARCH - 2009

CERTIFICATE

This is to certify that the Dissertation on **Outcome of Bubble CPAP ventilation in NICU** is a bonafide work, carried out in Chengalpattu Medical College, Chengalpattu, during 2007-2009 by **Dr.P.THIYAGARAJAN** under my supervision and guidance in partial fulfillment of the regulations laid down by The Tamil Nadu Dr. M.G.R. Medical University, for the M.D., Paediatrics, Branch - VIII Degree Examination to be held in March 2009.

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CONTENTS

INTRODUCTION

Neonatal and perinatal mortality rates are the major indicators for the health status of the nation. In developed countries, the neonatal and perinatal mortality rates are 3–5 and 8–9 per 1000 live births respectively[1,2]. In India, despite remarkable progress in urban areas neonatal and perinatal mortality rates are still high.

The current neonatal mortality rate (NMR) in India is 44 per 1000 live births (rural and urban being 46.7/1000 and 31.7 /1000 respectively)[3]. Many studies reveal that nearly half (32-52%) of this is due to respiratory distress in neonatal period[4,5]. Respiratory distress is one of the commonest problems of newborn occurring throughout the world (3-7% of all live births)[5-8].

In cases of respiratory distress -- adequate and immediate resuscitation, oxygen supplementation, maintenance of optimal temperature, timely referral and optimal ventilatory support will reduce the mortality.

Assisted ventilation is one of the important methods in the management of respiratory distress in neonates. It is an acute, short term intervention to support the physical process of respiration partially or completely till the newborn is able to breathe again unassisted.

There are two basic types of assisted ventilation.

1. Invasive ventilation

2. Non-Invasive ventilation

Invasive ventilation (although potentially lifesaving) is one of the more expensive therapies in neonatal intensive care. And it is not free of associated morbidity (higher incidence of bronchopulmonary dysplasia and retinopathy of prematurity in preterm infants and more chance for infection). It requires highly skilled medical personnel to operate and monitor the baby with frequent blood sampling (e.g.-ABG monitoring). Another expensive item other than the equipment is nursing and respiratory practitioner labour cost which varies from place to place.

Gentle Non-Invasive ventilation like Bubble CPAP has many advantages. Bubble CPAP is relatively simple and inexpensive. With pulseoximeter monitoring, these neonates can be effectively managed[9]. The long term morbidity is also less in Bubble CPAP, without any significant difference in mortality (Avery et al-1987)[10]. With trained persons it can be used in all secondary level hospitals to serve the purpose of large number of neonates in developing countries like India[11,12]. This sort of low cost interventions are the most cost effective method to reduce morbidity and mortality.

REVIEW OF LITERATURE

RESPIRATORY DISTRESS

As per the recommendations of National Neonatology Forum India[13] incidence of respiratory distress and subsequent perinatal mortality can be reduced by improved prenatal care, early detection , referral of high risk pregnancies, closer links between referral hospitals and health centers, close monitoring of labour to detect fetal distress and early intervention when indicated.

The usual manifestations of respiratory distress in neonates are tachypnea, retractions, grunting. Central cyanosis, lethargy and poor feeding. Various scoring systems are available to assess the severity of respiratory distress clinically. We used DOWNES SCORE to assess respiratory distress.

DOWNES SCORE

	0	1	2
Cyanosis	None	In room air	In 40% FIO2
Retractions	None	Mild	Severe
Grunting	None	Audible with stethoscope	Audible without stethoscope
Air entry	Clear	Decreased or delayed	Barely audible
Respiratory rate	Under 60	60-80	Over 80 or apnea

CAUSES OF RESPIRATORY DISTRESS

The common medical conditions in India [14]

1. Transient tachypnea of newborn (TTN)
2. Perinatal asphyxia
3. Respiratory distress syndrome (RDS)
4. Meconium aspiration syndrome (MAS)
5. Bronchopneumonia - sepsis
6. Aspiration
7. Pulmonary hypertension
8. Cardiac disorders
9. Neurologic disorders
10. Metabolic problems.

Surgical conditions include

1. Choanal atresia
2. Pneumothorax
3. Diaphragmatic hernia
4. Tracheo - esophageal fistula
5. Pierre Robin Syndrome (upper airway obstruction due to glossoptosis)
6. Congenital Lobar emphysema.

DISADVANTAGES OF INVASIVE VENTILATION IN RESPIRATORY

DISTRESS

Conventional mechanical ventilation via an endotracheal tube has undoubtedly led to improvement in neonatal survival. However the prolonged use of an endotracheal tube and mechanical ventilation may cause

1. Upper airway damage
2. Altered mucociliary flow
3. Nosocomial infection
4. Broncho Pulmonary Dysplasia
5. Volutrauma
6. Barotrauma
7. End-expiratory alveolar collapse

ADVANTAGES OF NON-INVASIVE VENTILATION IN RESPIRATORY

DISTRESS

Continuous Positive Airway Pressure is a method of delivering Positive End–Expiratory Pressure with a variable amount of oxygen to the airway of a spontaneously breathing neonate to maintain lung volume during expiration so as to reduce atelectasis and to improve oxygenation[15,16,17]. CPAP splints the chest, maintains end-expiratory volume (FRC) [18,19,20]. It supports the respiratory muscles which are at risk of fatigue. (Muller et al.)

HISTORY

CPAP was first used in 1971 to support breathing of preterm neonates. The first reported use of CPAP for the treatment of HMD was by Gregory *et al.* in 1971. In the seventies, Dr. Jen-Tien Wung at the Columbian Presbyterian Medical Center, New York developed the Bubble CPAP system using short nasal prongs[21]. In 1987, Avery et al published a retrospective study of 1625 neonates at eight tertiary centers[22]. In that study, Columbia University where the predominant mode of respiratory support was nasal CPAP, had the lowest incidence of chronic lung disease (CLD) without any significant difference in mortality.

Even in the pre- surfactant era and when antenatal steroid usage was uncommon, there was some evidence that early application of CPAP might reduce subsequent use of mechanical ventilation and the associated adverse outcome. Infants extubated to nasal CPAP experienced a reduction in respiratory failure necessitating assisted reventilation.

BENEFITS OF CPAP[23]

1. Reduces upper airway occlusion by decreasing upper airway resistance and increasing the pharyngeal cross sectional area.
2. Reduces right to left shunting.
3. Reduces obstructive apneas.
4. Increases the FRC.

5. Reduces inspiratory resistance by dilating the airways. This permits a larger tidal volume for a given pressure, thereby reducing the work of breathing.
6. Increases the compliance and tidal volume of stiff lungs with a low FRC by stabilizing the chest wall and counteracting the paradoxical movements.
7. Regularizes and slows the respiratory rate.
8. Reduces the incidence of apnea.
9. Increases the mean airway pressure and improves ventilation perfusion mismatch.
10. Conserves surfactant.
11. Diminishes alveolar edema.
12. Nasal CPAP after extubation reduces the proportion of babies requiring re-ventilation.
13. Oxygenation is related to the surface area of alveoli and carbon dioxide elimination is related to the minute volume. Normalizing lung volume improves both oxygenation and carbon dioxide elimination.

Fundamentally, the delivery of continuous positive airway pressure requires three components:

1. Flow generation
2. An airway interface
3. A positive pressure system.

FLOW GENERATION

Two major varieties exist - Constant flow and Variable flow. The flow generator usually also warms and humidifies the inhaled gases. Constant flow is usually provided by an infant ventilator which can be used in two ways. Most often, the amount of flow is set by the clinical team.

Alternatively, variable flow devices use a dedicated flow generator. Here the expiratory limb of the circuit is open to the atmosphere and the infant can draw extra gas from this limb to support inspiratory efforts. This device has gained widespread acceptance in Europe and North America. Despite the theoretical advantages of the variable flow device, there are no consistent data showing clinical long-term meaningful benefit over constant flow devices.

AIRWAY INTERFACE

Arrays of airway interfaces are in use:

single prongs

binasal prongs (short & long)

nasopharyngeal prongs

endotracheal tubes

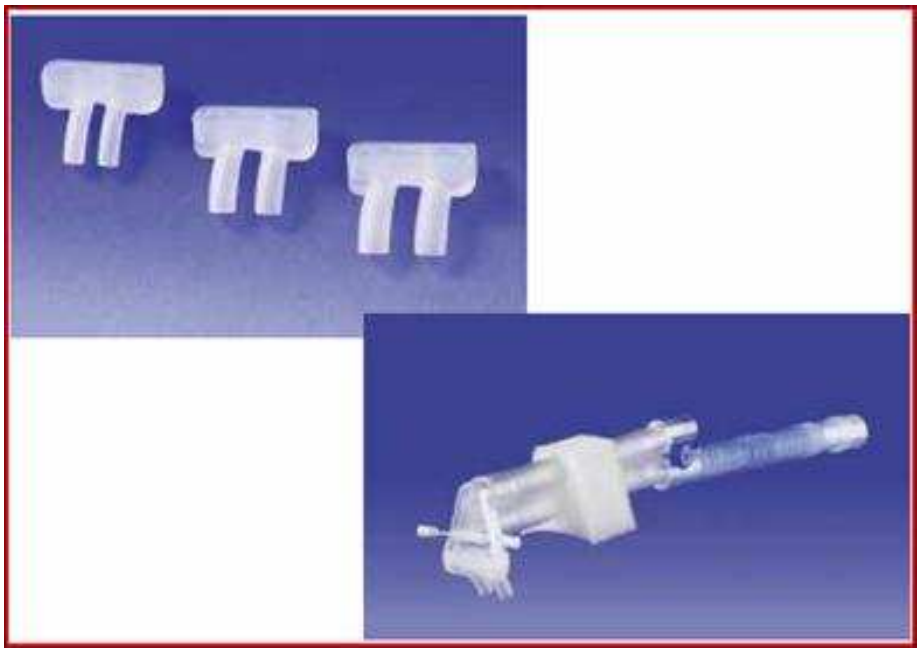
head boxes

pressurized plastic bags

nasal cannulae and face masks.

Nasal prongs are very easy to apply and non-invasive to the airways. The infant can still be nursed and handled with uninterrupted CPAP. A Cochrane Systematic Review suggests that short binasal prongs are more effective in preterm infants at preventing re-intubation compared to single nasal prongs. Nasal prongs can however cause nasal excoriation and scarring[24,25,26].

Short nasal prongs (Fisher & Paykel)



POSITIVE PRESSURE SYSTEM – can be of three types

1. The expiratory valve of the ventilator is used to adjust the expiratory pressure.
2. The pressure is generated by adjusting the inspiratory flow or altering the expiratory resistance.
3. The Bubble CPAP system produces a positive pressure by placing the far end of the expiratory tubing under water. The pressure is adjusted by altering the depth of the tube under the surface of the water.

BUBBLE CPAP

Essentially, the bubble CPAP system consists of three components:

1. A continuous gas flow into the circuit
2. An expiratory limb with the distal end submerged into a liquid to generate positive end expiratory pressure
3. Nasal interface connecting the infant's airway with the circuit.

As the gas leaves the circuit via the expiratory limb, it bubbles. Oxygen blender connected to wall oxygen and compressed air supply is used for supplying appropriate concentration of inspired oxygen[27,28,29].

Optimal gas flow is maintained with a flow meter to prevent rebreathing of carbon dioxide, increased work of breathing related to insufficient flow available for inspiration and to compensate for leakage in the CPAP system. Flow rate of 5 to 10 liters per minute is optimal for CPAP delivery in the neonates[30,31].

BUBBLE CPAP

OXYGEN FLOW GENERATOR WITH BLENDER

Pressure in the bubble CPAP system is created by placing the distal expiratory tubing in water. Designated pressure is determined by the length of expiratory limb being immersed. When the pressure is delivered to the baby without leakage, it results in continuous bubbling and the pressure oscillates in the circuit. Leakage is not obvious in ventilator CPAP. Though the pressure oscillation was once suggested to facilitate gas exchange, this postulation was not supported in another recent report[32,33].

CPAP is now used for a variety of neonatal conditions. It is effective in supporting the recently extubated infant and for treating apnea of prematurity. Increasingly, it is also seen as an alternative to intubation and ventilation in the treatment of HMD. Coupling CPAP with short duration

intubation and early delivery of a single dose of surfactant for moderate to severe HMD, improves oxygenation and reduces the need for mechanical ventilation[34,35]. This approach is known as the INSURE technique (Intubation, Surfactant administration, Rapid Extubation).

MONITORING:

The use of CPAP requires proper attention to the infant's airway. Both the correct prong size and proper positioning of the infant's neck are needed to avoid excessive flexion or extension. Optimal humidification of the inhaled gas should be ensured and the airway requires frequent suction to clear accumulated secretions. An oral gastric tube will help to relieve gaseous distension of the bowel.

Robertson *et al.*, demonstrated in a cohort of infants requiring CPAP, 20% had nasal complications - columella necrosis, flaring of the nostrils and snubbing of the nose. Observation and care of the nasal area is important in the nursing care of infants requiring nasal CPAP. Clinicians should be aware that CPAP has been associated with more serious complications including pneumothorax and air embolism[37,38]. Therefore all infants needing respiratory support be it, invasive or non-invasive continue to require careful monitoring for clinical deterioration. No compromises for CPAP should be made in this regard, and CPAP usage requires constant

observation of breathing patterns and standardized and rigorous training of physicians, respiratory practitioners and nursing staff.

NURSING CARE

Elaborate nursing care is pivotal for the success for Bubble CPAP. Proper positioning of the prongs can be secured by putting an appropriate size hat which rests along the lower part of the infant's ears and across his forehead with the circuit fastened on it. It has to be snugly fitted and stationed on the infant's head. Otherwise the circuit and the prong will move with the motion of the loosely fit hat. Tissue necrosis was observed if one was unable to keep the prong in the nostrils of an active infant.

Nasal trauma is common when the prong rests on the septum of the nose or on the columella. Proper application can prevent the accidental incarceration of the prong onto the nasal septum or the columella .Moreover adequate airway humidification and gentle nasal suctioning is paramount in maintaining a clear airway without jeopardizing the tissue integrity of the nostrils.

The probe and chamber temperature and the positioning of the temperature probe can be manipulated to minimize the "rain-out". Consistent bubbling is important to recruit alveoli, maintain functional residual capacity and reduce airway resistance and work of breathing especially in the early acute phase of respiratory distress. If the bubbling

stops it means that there is a pressure leak in the system, usually around the nostrils. It has been reported that the pharyngeal pressure drops markedly when the CPAP supported infant opens his mouth. Recent study demonstrated that, the prong pressure though not totally transmitted to the pharynx was more effectively transmitted when the mouth was closed. The use of chin strap or pacifier has been recommended to reduce mouth leak for effective CPAP support. However it should not be so tight as to prevent the infant from yawning or crying but tight enough to prevent leaking at rest. The infant's respiratory status has to be assessed at regular interval to evaluate effectiveness of the treatment and plan for subsequent care. CPAP has to be temporarily interrupted during chest auscultation as the bubbling sounds may interfere.

However, caution has to be taken as the infant may present with apnea and bradycardia when CPAP support is suspended for just a brief period. Gastric distension is common in the CPAP supported infant (CPAP Belly Syndrome). Frequent decompression of the stomach with an oro-gastric tube is necessary to promote comfort, preventing the distended stomach from splinting the diaphragm and compromising the respiration.

DEVELOPING WORLD AND CPAP

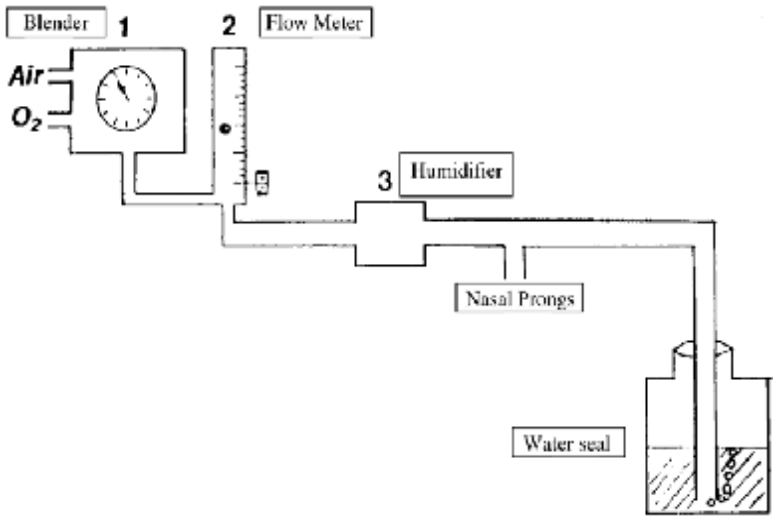
Many infants, with higher mortality and morbidity, are denied access to neonatal intensive care in the developing world because scarce financial

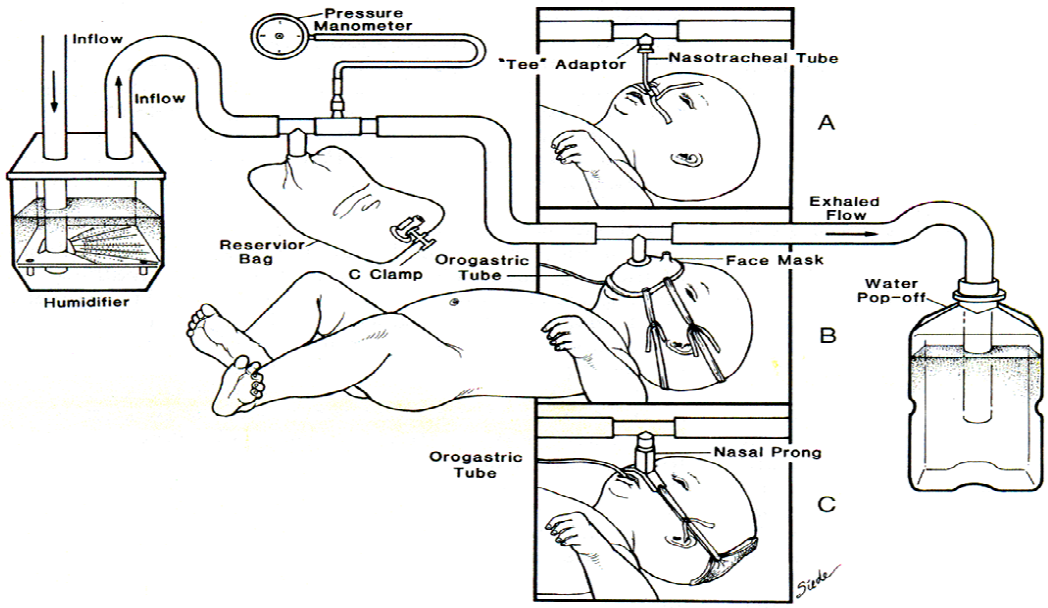
resources are directed towards more viable infants. In a prospective study from South Africa, Pieper *et al.* conducted a randomized control trial of CPAP for infants, birth weight 775 - 1160 gm who were denied access to NICU. When compared with the standard therapy of head box oxygen these babies treated with CPAP had better outcome.

Although the CPAP was initially placed by respiratory therapists, the ongoing care was continued by nursing staff with no intensive care or CPAP experience. The infants who received CPAP in these circumstances had a significantly improved short term survival (at 24 hours), with trends towards improved long-term survival[39].

SETTING UP A CPAP SYSTEM

The simplest and least expensive nasal CPAP system, to set up, is the Bubble CPAP system . One requires the equipment shown in *Table*.





Equipment for CPAP

Container with lid, filled with sterile water (or 0.25% acetic acid) to a depth of 10 cm H2O.
Column to fit through the lid of this container with graduated scale from 0-10 cm H2O.
Oxygen source, flow meter with blender, analyzer and oxygen tubing.
Inspiratory and expiratory circuits.
Manometer.
Heater and humidifier.
Nasal prongs with bonnet.

Fill the container with sterile water to 10 cm H2O and place the container below the level of the infant. The column should be fitted into the container through the lid and placed under the fluid level to desired pressure *i.e.,* initially 4-6cm H2O; the expiratory circuit from the infant is connected to the column. The expiratory circuit will need a port and pressure tubing

leading to a calibrated manometer. Snug fitting short, anatomical nasal prongs are secured with a bonnet and the inspiratory circuit is connected to the oxygen supply, flow meter, blender and analyzer via a humidified heater. A starting flow of 6L per min should be used, increasing to produce a steady stream of bubbles in the water container. The column can then be lowered or raised to the desired pressure to ensure steady bubbling.

General Indications for CPAP

1. Spontaneously breathing babies with respiratory distress at birth.
2. Increased work of breathing indicated by: recession, grunting, nasal flaring, increased oxygen requirements or increased respiratory rate.
3. Poorly expanded or infiltrated lung fields on chest *x*-ray.
4. Atelectasis.
5. Pulmonary edema.
6. Pulmonary hemorrhage.
7. Apnea of prematurity.
8. Recent extubation.
9. Tracheomalacia or other abnormalities of the airways, predisposing to airway collapse.
10. Phrenic nerve palsy.

Contraindications to CPAP

1. Upper airway abnormalities (cleft palate, choanal atresia).
2. Tracheo-esophageal fistula.
3. Diaphragmatic hernia.
4. Severe cardiovascular instability.

OBJECTIVE

AIM:

The objective is to study the outcome of non-invasive ventilation using Bubble CPAP in neonates with respiratory distress in Newborn Unit, Chengalpattu Medical College Hospital, Chengalpattu.

STUDY PERIOD

The study was conducted in Newborn Unit, Chengalpattu Medical College from January 2008 to June 2008 – (6 months period)

SUBJECTS

INCLUSION CRITERIA

Neonates admitted in Newborn Unit with respiratory distress

1. Down score 4 - 6
2. Oxygen saturation SPO2 < 85% even with supplemental oxygen included in the study.

EXCLUSION CRITERIA

Babies with

1. Severe respiratory distress (score > 7/10),
2. Unstable cardiovascular status,
3. Prolonged & refractory seizures
4. Major congenital anomalies including upper airway anomalies, pulmonary hypoplasia diaphragmatic hernia, etc,.

MATERIALS AND METHODS

During the six months period of January 2008 to June 2008, neonates admitted in our Newborn Unit with respiratory distress were included in this prospective study. All neonates with respiratory distress were given routine initial care and stabilized. Respiratory distress was diagnosed if any of the two of the following were present (NNF)

i. Respiratory rate > 60/min during quiet breathing
ii. Inspiratory retractions of chest
iii. Expiratory grunting.

Severity of respiratory distress was assessed by using DOWNES SCORE. Babies with total score < 4 were managed with Oxygen via hood at a rate of 6-8 liters/minute. If the distress increased they were started on Bubble CPAP. Babies with total score > 6 were intubated and given mechanical ventilation. If the distress decreased (score = 4-6) they were weaned to Bubble CPAP. Babies having initial total score between 4 – 6, were put on Bubble CPAP directly. If the distress increased they were intubated and started on mechanical ventilation. If the distress decreased they were weaned to oxygen gradually.

Investigations to diagnose the cause of respiratory distress were done including radiograph of the chest in all cases. Expert opinion was obtained from the radiologist. Blood sample was collected under sterile conditions

and sent for analysis (Complete Blood Count, micro ESR, peripheral smear study, Glucose, Urea, Creatinine, Calcium, other electrolytes, Culture & Sensitivity etc.). Blood pressure was monitored with a non-invasive blood pressure monitor. Hypotension (mean BP < 30 mm Hg) was corrected with plasma expanders and dopamine drip as and when indicated. The sensor of a pulse oximeter was placed around the foot to continuously monitor the SPO2 and heart rate and it was shielded from light and heat.

Indications for shifting to CPAP ventilation were,

(i) Downe score 4 – 6
(ii) Oxygen saturation SPO2 < 85% even with supplemental oxygen

A Bubble CPAP system (Fisher & Paykel) was used to deliver CPAP through short nasal prongs placed in both anterior nares and secured firmly with a cotton tape tied around the head. The nasal prongs were checked for any displacement regularly and for blockage due to secretions every 4 hours.

Initial CPAP Settings :

(i) FiO2 : 0.6 to 0.8

(ii) Flow rate : 5 to 10 liter/minute

(iii) CPAP: 4 to 6 cm water with increment of 2 cm at a time, up to a maximum of 10 cm of water to achieve SPO2 of 85 to 90%.

All the infants recruited in the study were followed till discharge or death. Duration of CPAP, course of the illness, changing of treatment modalities from CPAP to IMV, weaning from IMV to CPAP, weaning from CPAP to oxygen and complications of CPAP were meticulously documented.

Following outcomes were taken into account.

- Weaned from CPAP and discharged
- CPAP failure
- Mortality in the study population.

WEANING :

When SPO2 reached 90% or more the FiO2 was lowered in decrements of 0.05 to maintain a SPO2 of > 85%. When the FiO2 could be lowered to 0.5 or less CPAP was reduced in decrements of 2 cm of water. The nasal prongs were removed when the CPAP was < 3 cm of water at FiO2 < 0.4.

CPAP FAILURE - was defined as

- Persistent SPO2 of < 85% and/or rising Downes score over 6
- Recurrent apneic spells or poor respiratory effort.

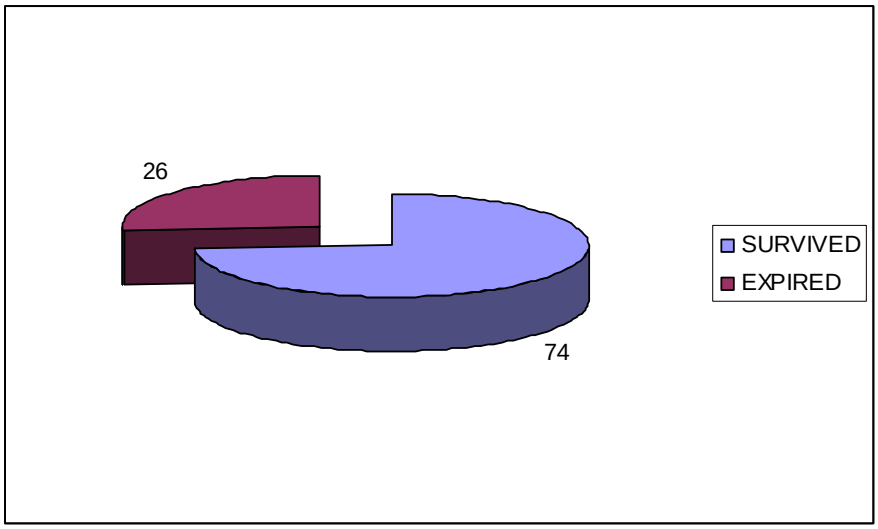
The efficacy of CPAP ventilation was analyzed in different weight groups. The success being defined as persistent SPO2 > 85% and survival. CPAP failures were shifted to IPPV. Infants on IPPV were monitored by pulse oximetry.

RESULTS AND DISCUSSION

Out of the 2812 babies born at our hospital during the 6 months study period, 102 (3.6%) babies were admitted to the neonatal intensive care unit (NICU) for respiratory distress. 18 cases were excluded from the study due to various reasons like severe respiratory distress, unstable cardiovascular status, refractory seizures during admission. Four babies in the study group were delivered at home. 9 babies in the study group were delivered at nearby government hospitals and referred here for management of respiratory distress. Three babies in the study group were delivered in private hospital. There were 39 males and 61 females in the study group. 16% babies in the study were delivered by caesarian section.

OUTCOME

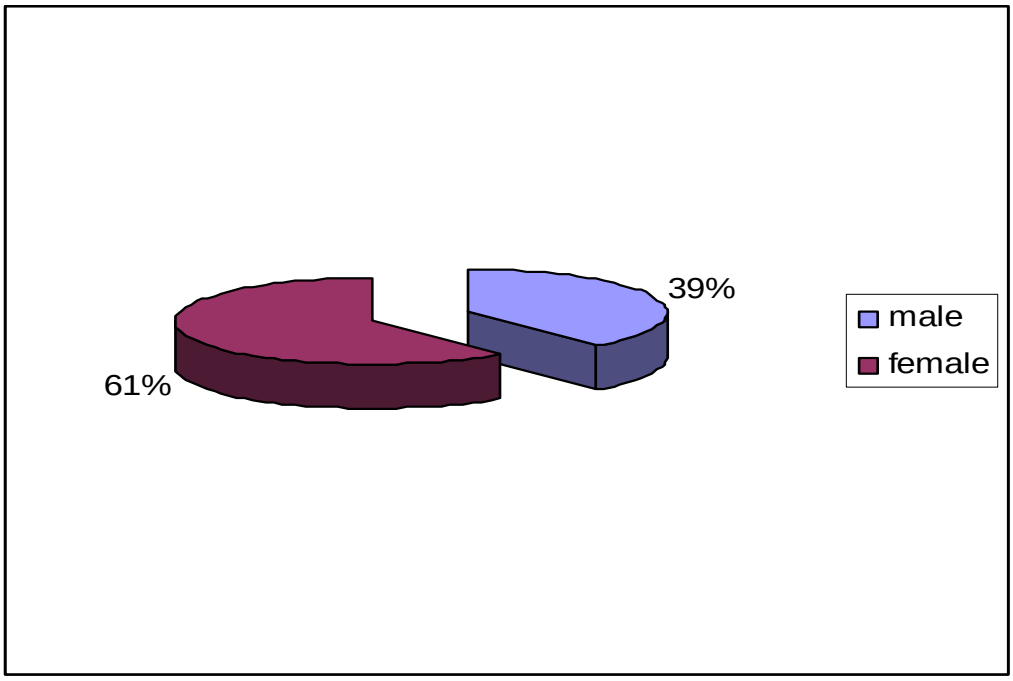
In our study out of 100 neonates with respiratory distress 74 babies weaned from CPAP ventilation and discharged. 26 babies succumbed to the illness. Mortality was high in babies weighing < 1.5 kg, and babies with sepsis.



SEX WISE DISTRIBUTION

Male - 39

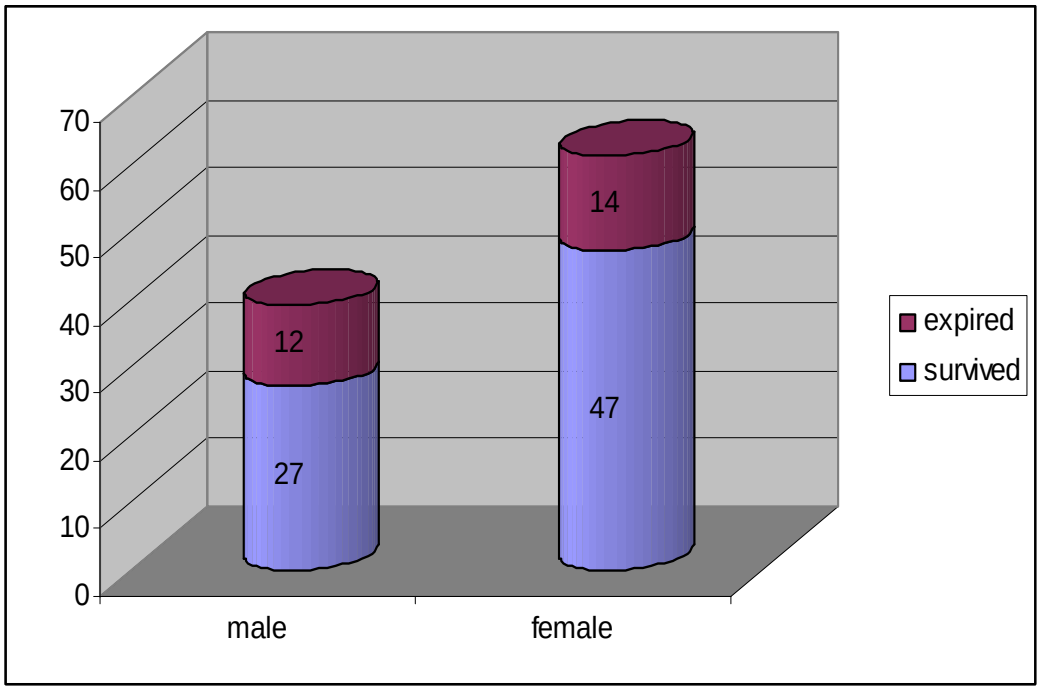
Female - 61



SEX WISE SURVIVAL

Out of 39 male babies 27 (69 %) survived

Out of 61 females 47 (77%) survived

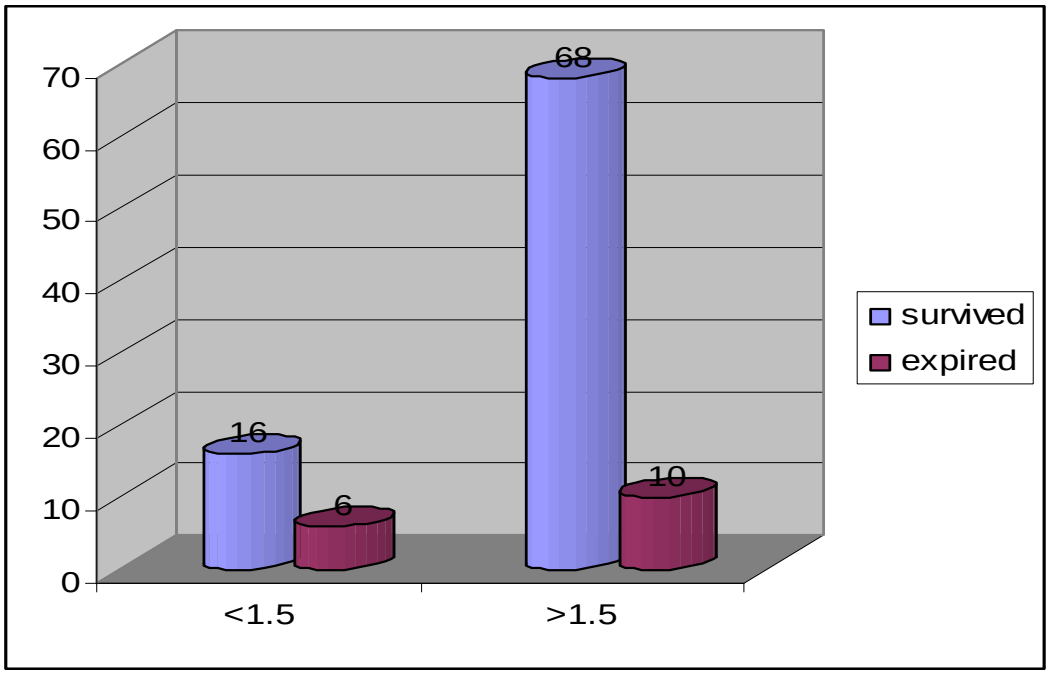


BIRTH WEIGHT WISE DISTRIBUTION

Wt < 1.5 kg = 22 babies. Out of these 16 babies (72%) survived.

Wt > 1.5 kg = 78 babies. Out of these 68 babies (87%) survived.

The mean birth weight of the babies under study was 2217 gm (800-4000 gm). The overall prognosis of babies weighing more than 1500 gm was good with survival of 87%. Survival of babies in the weight group <1500 gm was 27%. .

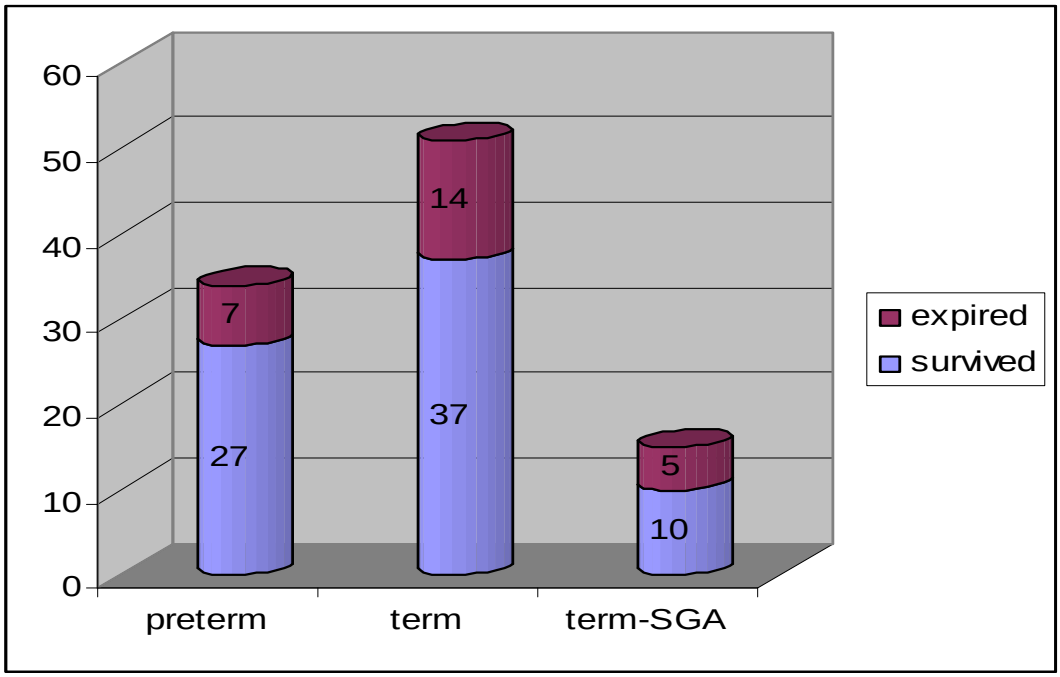


SURVIVAL IN TERM & PRETERM BABIES

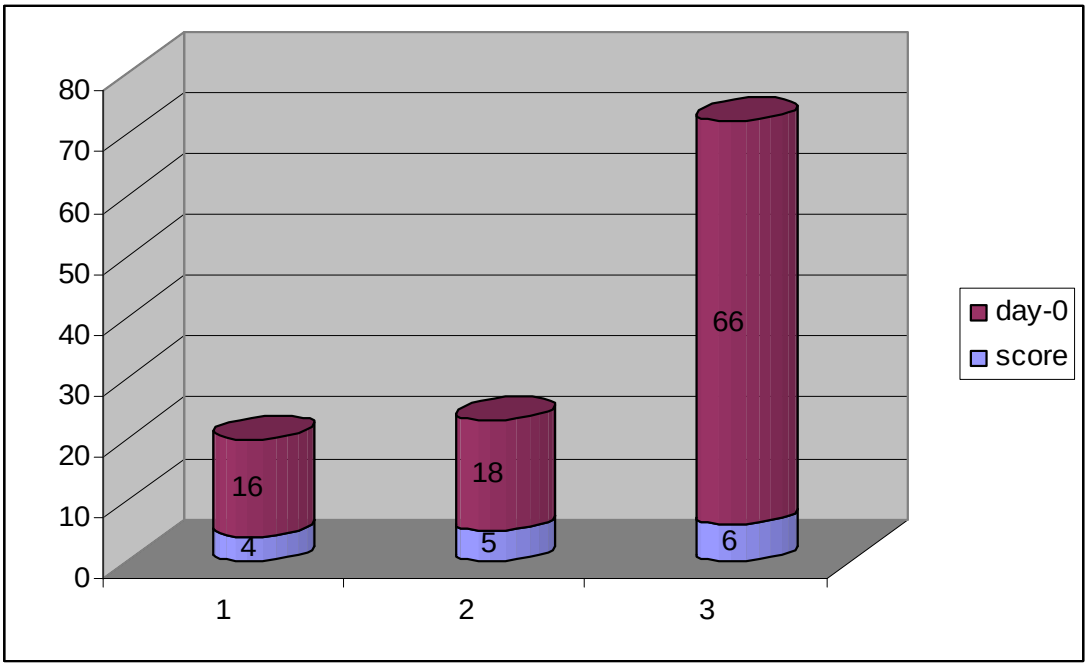
Out of 34 Preterm babies 27 babies (79%) survived

Out of 51 Term AGA babies 37 babies (72%) survived

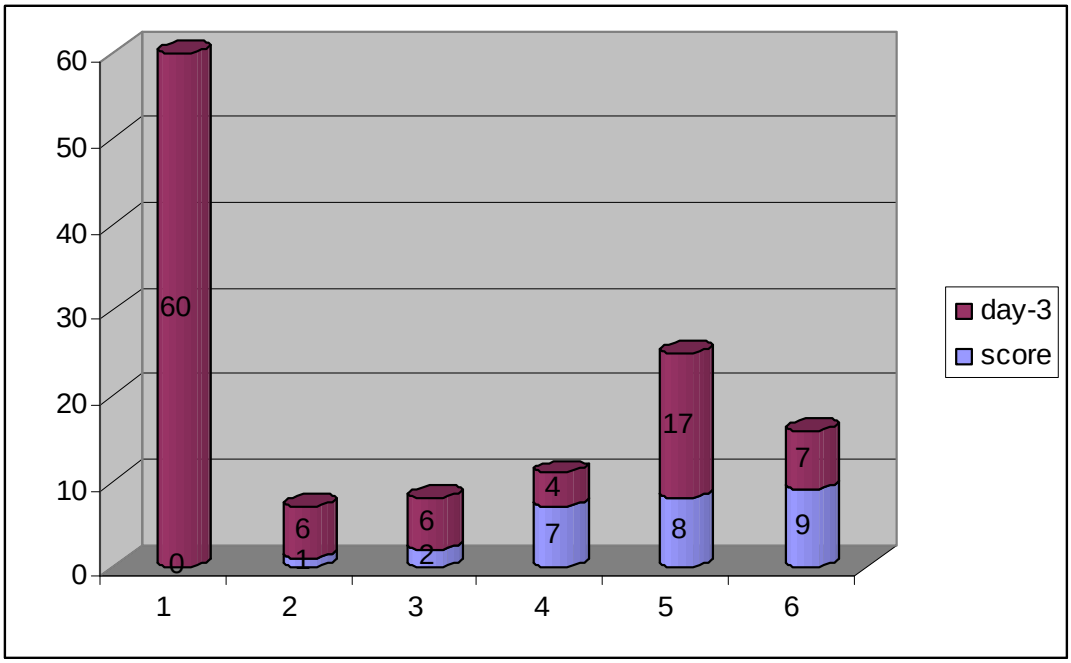
Out of 15 Term IUGR babies 10 babies (66%) survived



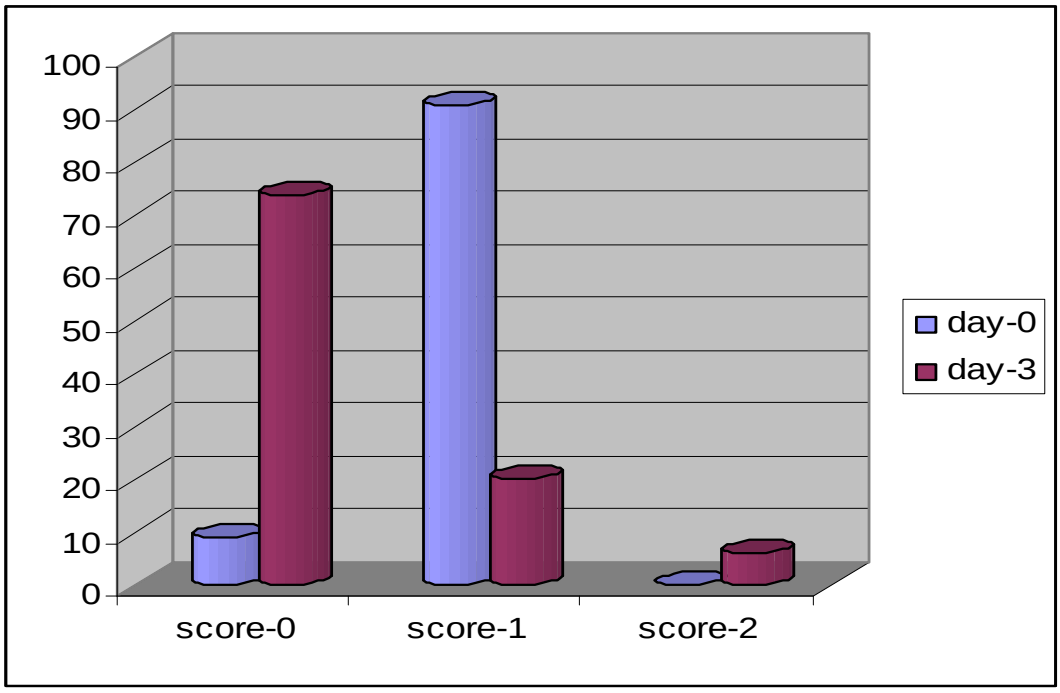
DOWNES SCORE ON DAY- 0



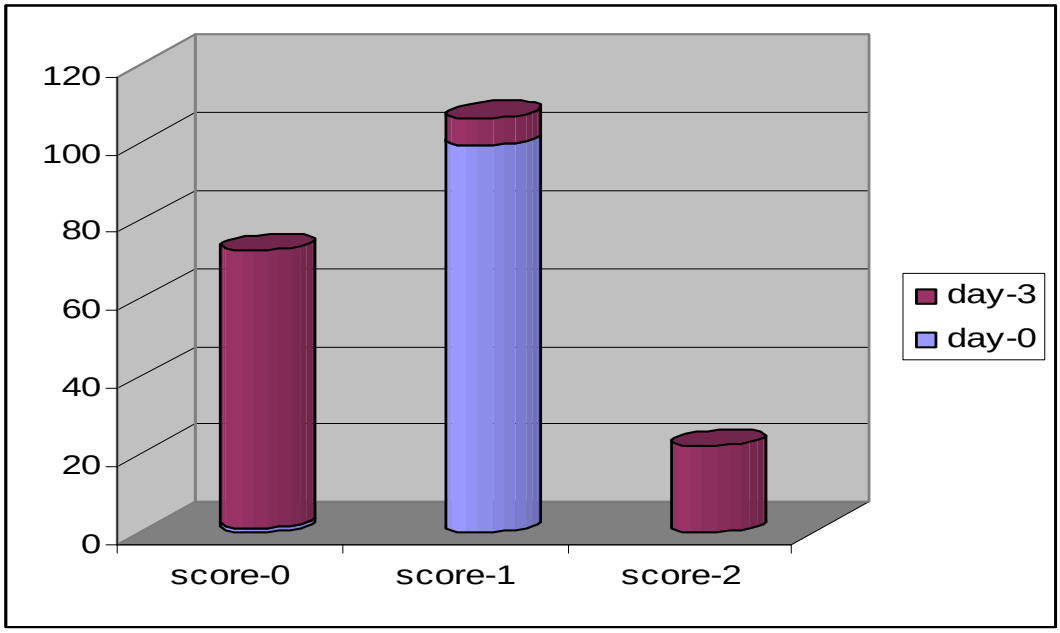
DOWNES SCORE ON DAY-3



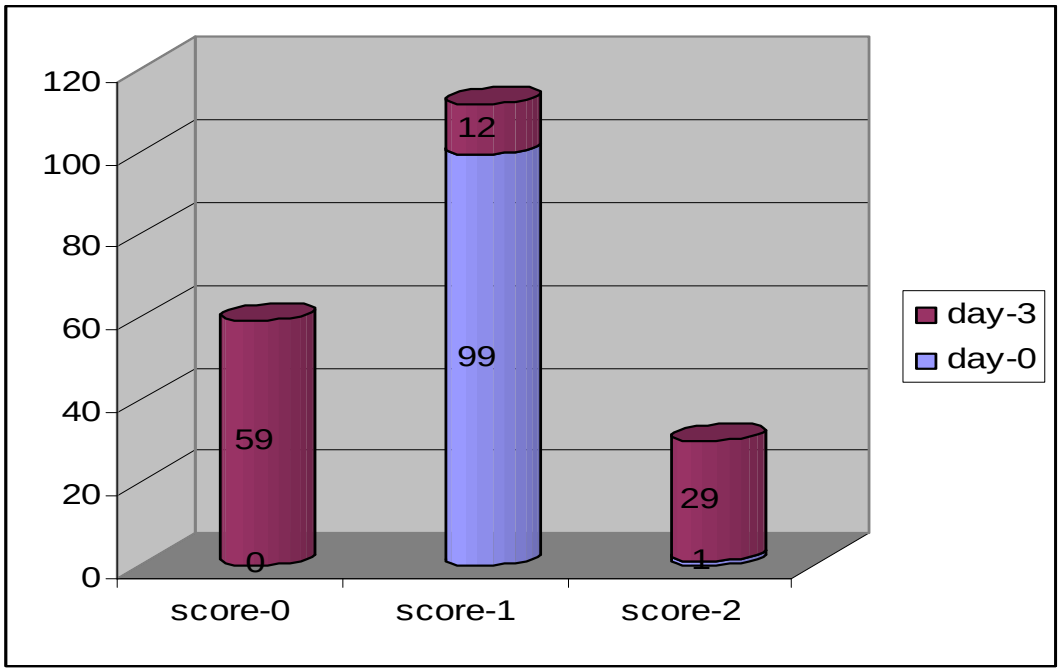
CYANOSIS SCORE ON DAY- 0 AND DAY- 3



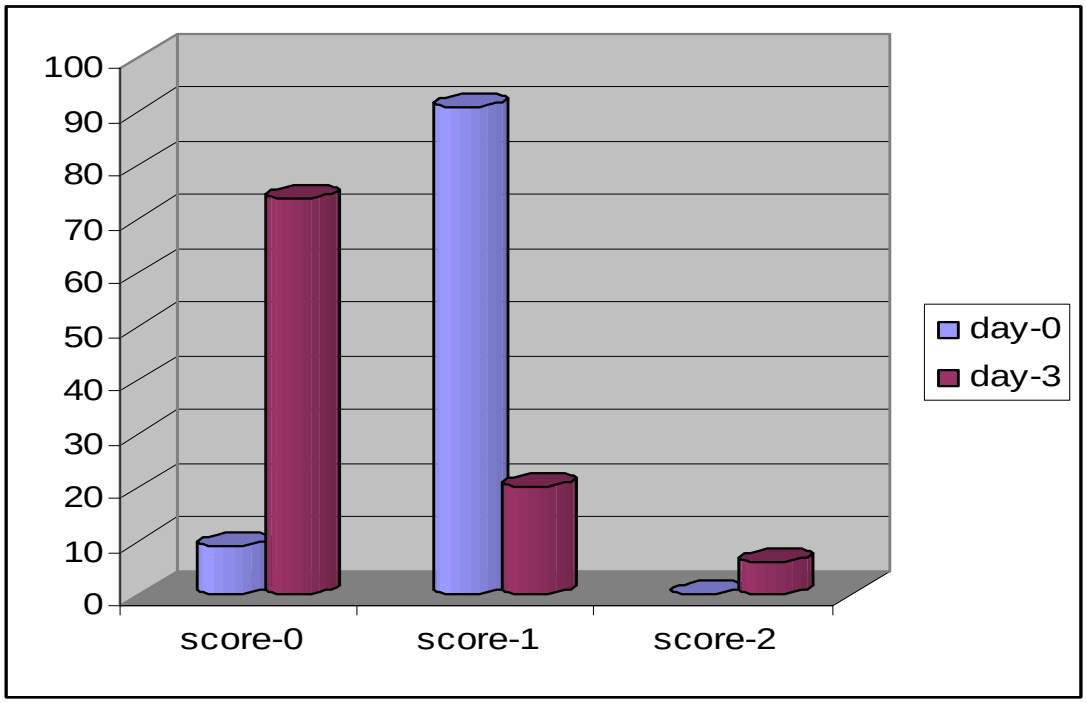
GRUNTING SCORE ON DAY-0 AND DAY-3



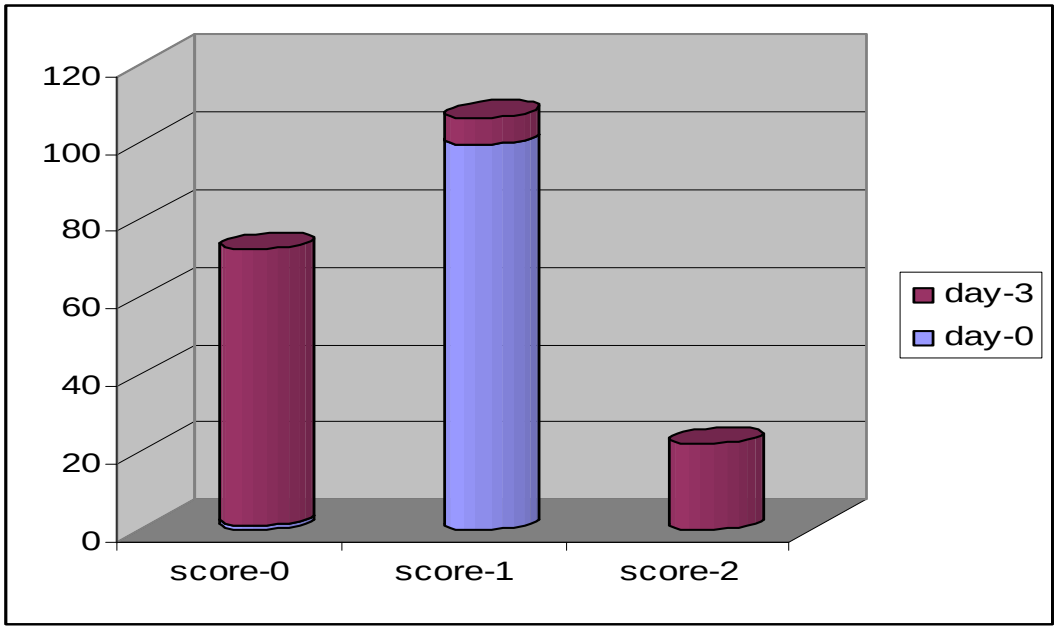
RESPIRATORY SCORE ON DAY- 0 AND DAY - 3



AIR ENTRY SCORE ON DAY- 0 AND DAY - 3



CHEST RETRACTION SCORE ON DAY- 0 AND DAY - 3



STATISTICAL ANALYSIS

T test cy0=cy3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
cy0	100	.91	.0287623	.2876235	.8529293	.9670707
cy3	100	.32	.0583961	.5839607	.2041295	.4358705
diff	100	.59	.0621094	.6210939	.4667615	.7132385

Ho: mean (cy0 - cy3) = mean (diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean(diff) > 0
t = 9.4994	t = 9.4994	t = 9.4994
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test rr0=rr3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
rr0	99	2	0	0	2	2
rr3	99	.7070707	.0899535	.8950262	.5285609	.8855805
diff	99	1.292929	.0899535	.8950262	1.114419	1.471439

Ho: mean (rr0 - rr3) = mean(diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean(diff) >0
t = 14.3733	t = 14.3733	t = 14.3733
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test gr0=gr3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
gr0	100	.99	.01	.1	.9701578	1.009842
gr3	100	.51	.0834787	.8347866	.3443602	.6756398
diff	100	.48	.0834605	.8346051	.3143962	.6456038

Ho: mean (gr0 - gr3) = mean (diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean (diff) > 0
t = 5.7512	t = 5.7512	t = 5.7512
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test air0=air3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
air0	100	.95	.0219043	.2190429	.9065371	.9934629
air3	100	.54	.0869459	.8694594	.3674804	.7125196
diff	100	.41	.0888706	.8887058	.2336615	.5863385

Ho: mean (air0 - air3) = mean (diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean (diff) > 0
t = 4.6135	t = 4.6135	t = 4.6135
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test re0 = re3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
re0	100	1.15	.0411329	.4113295	1.068383	1.231617
re3	100	.49	.073161	.7316095	.3448328	.6351672
diff	100	.66	.0806789	.8067894	.4999155	.8200845

Ho: mean (re0 - re3) = mean (diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean (diff) > 0
t = 8.1806	t = 8.1806	t = 8.1806
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test tot0=tot3

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
tot0	100	6	.0586033	.5860327	5.883718	6.116282
tot3	100	2.46	.3610926	3.610926	1.743514	3.176486
diff	100	3.54	.3577201	3.577201	2.830206	4.249794

Ho: mean (tot0 - tot3) = mean (diff) = 0

Ha: mean (diff) < 0	Ha: mean (diff) ~= 0	Ha: mean (diff) > 0
t = 9.8960	t = 9.8960	t = 9.8960
P < t = 1.0000	P > |t| = 0.0000	P > t = 0.0000

T test tot3, by (dead1)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	74	.6351351	.1977046	1.70072	.2411104	1.02916
1	26	7.653846	.4504436	2.296821	6.72614	8.581552
combined	100	2.46	.3610926	3.610926	1.743514	3.176486
diff		-7.018711	.4265329		-7.865152	-6.17227

Degrees of freedom: 98

Ho: mean (0) – mean (1) = diff = 0

Ha: diff < 0	Ha: diff ~= 0	Ha: diff > 0
t = -16.4553	t = -16.4553	t = -16.4553
P < t = 0.0000	P > |t| = 0.0000	P > t = 1.0000

logistic dead1 tot3 age sex bwt

no observations

r(2000);

logistic dead1 tot3 age sex1 bwt

Logit estimates	Number of obs	=	100
	LR chi2(4)	=	78.84
	Prob > chi2	=	0.0000
Log likelihood = -17.885725	Pseudo R2	=	0.6879

dead1	OddsRatio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tot3	2.128297	.3029425	5.306	0.000	1.610171	2.813148
age	1.824714	1.598525	0.687	0.492	.3277229	10.15975
sex1	.4002889	.4075939	-0.899	0.369	.0544049	2.945161
bwt	.5493918	.2931049	-1.123	0.262	.1930898	1.563165

CYANOSIS

Variable	Observed	Mean	Std. error	Std. deviation
Score – day 0	100	0.91	0.0287	0.287
Score – day 3	100	0.32	0.0583	0.583
Difference	100	0.59	0.0621	0.621

RESPIRATORY RATE

Variable	Observed	Mean	Std. error	Std. deviation
Score – day 0	100	2	0	0
Score – day 3	100	0.707	0.0899	0.895
Difference	100	1.29	0.0899	0.895

GRUNTING

Variable	Observed	Mean	Std. error	Std. deviation
Score – day 0	100	0.99	0.01	0.1
Score – day 3	100	0.51	0.0834	0.8347
Difference	100	0.48	0.0834	0.8346

AIR ENTRY

Variable	Observed	Mean	Std. error	Std. deviation
Score – day 0	100	0.95	0.0219	0.219
Score – day 3	100	0.54	0.0869	0.869
Difference	100	0.41	0.0888	0.888

RESPIRATORY EFFORT

Variable	Observed	Mean	Std. error	Std. deviation
Score – day 0	100	1.15	0.0411	0.411
Score – day 3	100	0.49	0.0731	0.731
Difference	100	0.66	0.0806	0.806

TOTAL SCORE

Variable	Observed	Mean	Std. error	Std. deviation
Downes score – day 0	100	6	0.0586	0.5860
Downes score – day 3	100	2.46	0.3610	3.610
Difference	100	3.54	0.3577	3.577

OUTCOME OF BUBBLE CPAP VENTILATION

GROUP	Observed	Mean	Std. error	Std. deviation
0	74	0.6351	0.1977	1.700
1	26	7.6538	0.4504	2.296
Combined	100	2.46	0.3610	3.610
Difference	100	0.59	0.4265	4.265

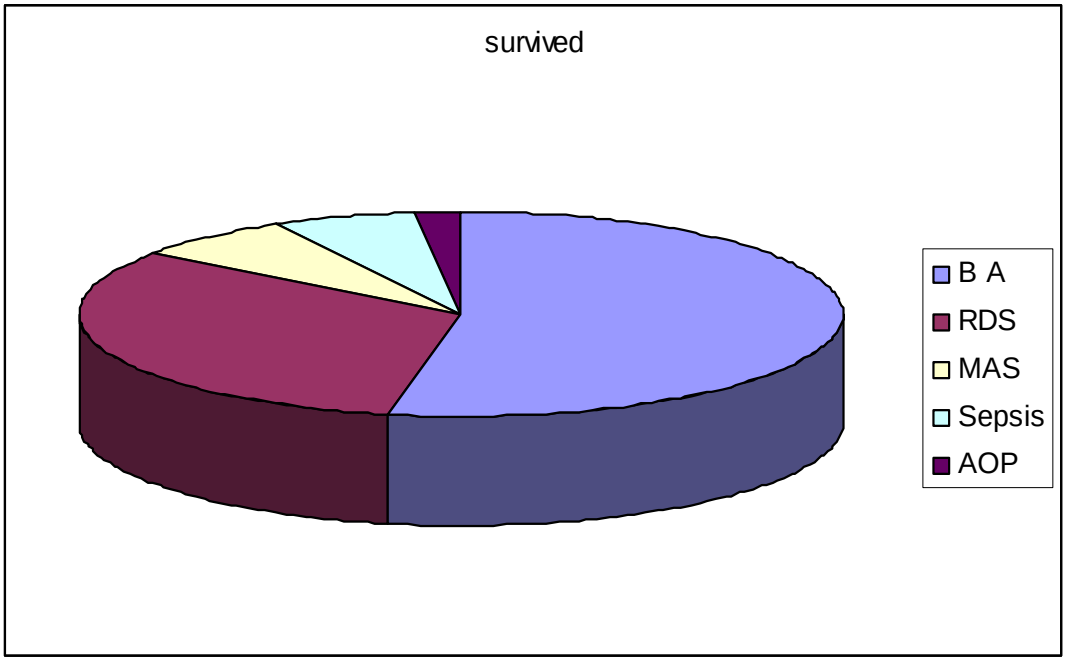
In this study there was significant improvement of respiratory distress in the babies treated Bubble CPAP. All parameters like – cyanosis, grunting, tachypnea, chest indrawing and air entry improved with Bubble CPAP administration. There was significant reduction of mortality in babies with respiratory distress while using Bubble CPAP. ($P < 0.0001$)

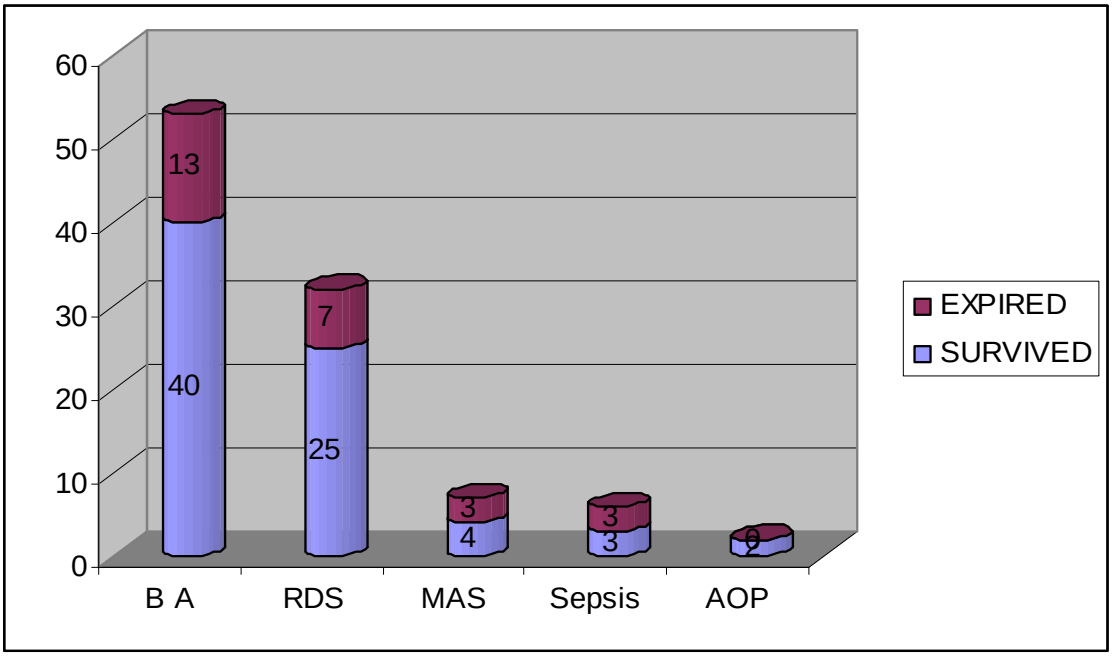
The mean duration of CPAP administered in this study was 28 hours (range 6-72 hours). Among the 30 CPAP failures, 21 failed within the first 24 hrs. While 9 did well for the first 24 hours they failed to maintain the desired SaO2 and had to be shifted to IPPV after 24 hrs. Among these 9 babies, four improved and weaned to CPAP again after 24 to 48 hrs.

Various causes of respiratory distress and their outcome observed in this study were,

1. Perinatal Asphyxia = total 53 babies. Out of these 40 babies (75%) survived.
2. Preterm – RDS = total 32 babies. Out of these 27 babies (84%) survived
3. Preterm- Apnea of prematurity – 2 babies. Both babies (100%) were weaned from CPAP.
4. MAS = total 7 babies. Out of these 4 babies (57%) survived
5. Bronchopneumonia – Sepsis = total 6 babies. Out of these 3 babies (50%) survived

Out of this, 16 babies with RDS and all babies with MAS & Sepsis had significant radiological findings.





Various studies have stated that, CPAP is useful in the treatment of RDS with survival rates of 67-83%. In our study 27 (84%) of the 32 neonates with RDS survived on CPAP. We treated 7 infants of MAS with CPAP ventilation, of which 4 (59%) survived. The distending pressure of CPAP directly stimulates the pulmonary stretch receptors increasing the ventilatory drive. Infants suffering from septicemia had high mortality, with only 3 of the 6 cases treated surviving, however, the cause of death in such cases is multifactorial.

Overall neonatal mortality due to respiratory distress had come down in our Newborn unit after using Bubble CPAP. Neonatal mortality due to respiratory distress was 45% prior to the use of Bubble CPAP. After using Bubble CPAP, neonatal mortality due to respiratory distress was 28% only.

COMPLICATIONS

There were few complications of nasal CPAP in our study. Displacement of the nasal prongs was a very common problem whereas blockage due to secretions occurred rarely. Displacement of nasal prongs was quite troublesome and required dedicated staff to replace it frequently. However, this has to be seen in comparison with the expertise required for intubation, the problems of keeping it free of secretions and its long- term complications.

Mild ulcerations of nasal mucosa occurred in 4 (4%) infants that healed without scarring. Six babies (6%) developed gastric distension which subsided within 24 hrs. Transient hypotension noted in 2 babies which was corrected with fluid bolus.

Pneumothorax didn't occur. None had the complications of oxygen toxicity. CPAP failures faired poorly on IPPV also, irrespective of their weight. There was no incidence of skin injury or burn due to the probe of the pulse oximeter.

CONCLUSION

Considering that inexpensive CPAP resuscitators and pulse oximeters are now available, we conclude that, this form of therapy should be adopted even by the smaller hospitals to improve the survival of neonates with respiratory distress.

SUMMARY & RECOMMENDATIONS

Most of our level-2 hospitals treat respiratory distress in newborns with oxygen alone and accept high mortality and morbidity. Establishing a NICU in smaller hospitals with equipment, expertise and staffing for IPPV and ABG analysis is neither economically viable practical.

Although ABG monitoring has distinct advantages, it requires considerable expertise, is invasive and not easily available. Conversely, pulse-oximetry not only monitors oxygen saturation of hemoglobin continuously but is also simple and noninvasive. We found nasal CPAP ventilation complemented with pulse -oximetry, a simple and efficient method for treating neonates with respiratory distress.

Concerns about the damaging effects, and expense, of conventional mechanical ventilation have led neonatologists to seek new methods of respiratory support for the preterm infant such as non-invasive respiratory support. Non-invasive pressure support is useful because it can limit lung injury namely Volutrauma,

Barotrauma and Atelectotrauma. CPAP maintains FRC, recruitment, decreases upper airway collapse and promotes the release and conservation of surfactant.

CPAP is effective in preventing extubation failure and also in the management of apnea of prematurity. The low cost of CPAP systems coupled with a standardized training for physicians and nursing staff, may be of benefit in the developing world with finite finances for supporting newborn babies with respiratory distress.

Even though Bubble CPAP is less costly when compared to mechanical ventilator the cost could still be reduced by making it with indigenous products for the benefit of our community. Many multicentric trials have to be done in this regard for the benefit of the community at large.

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MODEL PROFORMA

Name: …… Age: …… Sex: M / F

IP No:…….. DOB:……

Place: ChMCH / GH / PHC/ NH / Home

Mode: LN / Breech / Forceps / LSCS (Indication:)

B.WT: >4 / > 2.5 / 1.5 - 2.5 / < 1.5

Term / Preterm: AGA / SGA / LGA: Gestational Age :

Apgar:1mt : 5 mt: 10 mt:

MATERNAL DETAILS

Name : ……..……Age : G: P: L: A:

LMP : EDD : Blood Gp : MRO / PROM :

Antenatal steroids : Y / N Received Antibiotics : Y / N Other risk factors: HT/ DM/

NICU DETAILS

DOA:

Indication for Admission : Diagnosis on Admission :

O/E: Colour – pink/ acro cyanosis/ central cyanosis :

cry & activity : HR : > 100 / mt (or) < 100 / mt:

RR : Resp. Distress: Y / N: SpO: CRT :

DOWNES SCORE

	0	1	2
Cyanosis	None	In room air	In 40% FIO2
Retractions	None	Mild	Severe
Grunting	None	Audible with stethoscope	Audible without stethoscope
Air entry	Clear	Decreased or delayed	Barely audible
Respiratory rate	Under 60	60-80	Over 80 or apnea

CVS : RS : ABDOMEN ; CNS :

(INVESTIGATIONS) : X – Ray chest : others:

Treatment :

Outcome :

MECHANICAL VENTILATION :

Indications for ventilation : apnea / ^ wob / desat / failed CPAP / hypoventilation / shock

Sedation : yes / no : Size of ETT tube : 2.5/ 3/ 3.5/ 4 : Depth :

Date of intubation : Date of extubation :

Date & time	Mode	FiO2	PIP	PEEP	Rate	SpO2	HR	BP	Perfu sion	Drugs given	Remarks

Complications during ventilation: tube block/ Acc. Extubation/ aspiration/ pneumothorax/ pulm. hge/ VAP/

Post extubation status : normal / cpap / reintubation / stridor / other complications

Outcome :

NASAL CPAP :

Indications for CPAP : Size of nasal prongs :

Date & time	FiO 2	CPAP	Flow	SpO2	Rate	S. score	CNS status	Drugs given	Remarks

Complications during CPAP :

Date of application : Date of weaning :

Post weaning status : normal / cpap /reintubation / stridor / other complications

Outcome :